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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/927,428	08/09/2001	Wenbing Yun	LBL-IB-1498	6387
8156	7590	04/14/2004	EXAMINER	
JOHN P. O'BANION O'BANION & RITCHEY LLP 400 CAPITOL MALL SUITE 1550 SACRAMENTO, CA 95814			DEO, DUY VU NGUYEN	
			ART UNIT	PAPER NUMBER
			1765	

DATE MAILED: 04/14/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/927,428

Applicant(s)

YUN ET AL.

Examiner

DuyVu n Deo

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. ✓ 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-123 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 99-104 is/are allowed.
- 6) ☒ Claim(s) 1-28, 30-62, 64-80, 82-85 and 88-96 is/are rejected.
- 7) ☒ Claim(s) 29, 63, 81, 86, 87, 97 and 98 is/are objected to.
- 8) ☒ Claim(s) 105-123 are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- 1) ☐ Certified copies of the priority documents have been received.
 - 2) ☐ Certified copies of the priority documents have been received in Application No. ____.
 - 3) ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|--|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date ____ | 6) <input type="checkbox"/> Other: ____ |

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DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

2. Claims 1, 2, 7-11, 13, 16, 18, 28, 29, 34-38, 40, 41, 43, 45, 50, 55, 60, 61, 63, 64, 66, 67, 69, 71, 76, 82-84 are rejected under 35 U.S.C. 102(b) as being anticipated by Zandveld (US 4,104,085).

Zandveld describes a method for etching a substrate comprising: bombarding the surface of the wafer having a silicon (di)oxide layer with argon ions having energy of at least 20 keV with the depth depending on the ions concentration and energy (claimed irradiating the wafer surface with a charged particle beam of suitable energy) and this would form claimed particle tracks; forming a pattern photoresist on the irradiated wafer surface; etching the wafer with a solution according to the etching pattern (col. 3, line 50-col. 4, line 50; figure 1-5). Referring to the limitations of the particle tracks capable of discrete etching guided by particle tracks or the etching is guided by the particle tracks, these claims describe the properties of the particle tracks. Since Zandveld's method form particle tracks, it would be inherently to have those properties.

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Referring to claims 2, 10, 29, 37, 38, 55, 63, 64 figure 2 shows the charged particle beam is of predetermined collimation and at a desired direction (perpendicular) with respect to the wafer surface.

Referring to claim 9, the argon ions are used for the ion implantation (col. 3, line 64-68). This would read on claimed charged particle beam is produced by removing some or all electron from neutral atoms. Method, such as using an accelerator, to produce such ions are known by one skilled in the art as shown in page 9, line 1-2 of specification.

Referring to claims 11, 13, 38, 40, 64, 66 figure 2 from Zandveld shows the direction is perpendicular to the wafer surface and the particle tracks formed would be substantially parallel to each other. Claims 14, 41, 67 do not have patentable weight because it is an optional limitation.

Referring to claim 84, the material is silicon dioxide (claimed quartz crystal or silica glass) (col. 3, line 53).

3. Claims 1-4, 7, 8, 10, 14, 16, 18, 28-31, 34, 35, 37, 41, 43, 45, 55-57, 60, 61, 63, 67, 69, 71 are rejected under 35 U.S.C. 102(e) as being anticipated by Liu et al. (US 6,271,127).

Liu describes a method for forming dual damascene comprising: exposing the substrate surface with and electron beam or ion implantation with suitable energy (claimed irradiating the wafer surface with a charged particle beam of suitable energy) and this would form claimed particle tracks with a desired depth and alignment; depositing and developing a resist to form an etching pattern on the wafer (claimed depositing and removing portions of the resist layer to generate an etching pattern on the wafer); etching the wafer according to the etching pattern (col. 7, line 21-44; col. 8, line 20-30). Referring to the limitations of the particle tracks capable of

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discrete etching guided by particle tracks or the etching is guided by the particle tracks, these claims describe the properties of the particle tracks. Since Liu's method form particle tracks, it would be inherently to have those properties.

Referring to claims 2, 10, 29, 37, 55, 63, even though Liu is silent about the charged particle beam is of predetermined collimation and at a desired direction with respect to the wafer surface, the electron beam or ion implantation would have to carry a certain collimation and at a certain direction (claimed predetermined collimation at a desired direction) with respect to the wafer surface. Claims 14, 41, 67 do not have patentable weight because it is an optional limitation.

Referring to claims 3, 4, 24, 25 the wafer would comprise a negative of a final nanomachined structure for the depositing of metal interconnection (col. 7, line 51-59).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 9, 11, 13, 36, 38, 40, 62, 64, 66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu as applied to claims 1, 10, 28, 37, 55, 63 above, and further in view of Zandveld (US 4, 104,085).

The ion implantation taught by Liu is known to one skilled in the art. Zandveld describes such ion implantation method using argon ions (col. 3, line 64-68). This would read on claimed

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charged particle beam is produced by removing some or all electron from neutral atoms.

Method, such as using an accelerator, to produce such ions are known by one skilled in the art as shown in page 9, line 1-2 of specification.

Referring to claims 11, 13, 38, 40, 64, 66 figure 2 from Zandveld shows the direction is perpendicular to the wafer surface and the particle tracks formed would be substantially parallel to each other

6. Claims 15, 17, 19-22, 42, 44, 46-49, 68, 70, 72-75, 90, 92 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu or Zandveld or Liu/admitted prior art or Zandveld/admitted prior art as applied to claims 1, 28, 55, 88, and further in view of Hashimoto et al. (US 4,976,818).

The process of forming pattern in the photoresist is known to one skilled in the art as describes here by Hashimoto. This process include spin coating, electron beam exposure, and develop in a solvent (col. 2, line 46-54). Since it is formed by the same method, it would suitable for removing portions as small as 5 nm width.

Hashimoto also teaches using multi-layer resist system because it improves dry etch resistance and suppress the proximity effect due to reflection of electrons. The multi resist system is processed with dissolution of selective portions of the resist layer using a solvent and a plasma based etching (col. 1, line 18-31; summery; col. 2, line 39-61).

7. Claims 23-25, 50-52, 76-78, 88, 89, 94-96 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu or Zandveld as applied to claims 1, 28, 55 above, and further in view of applicant's admitted prior art.

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Unlike claimed invention, Liu is silent about the chemistry being used for etching of the wafer. Method for etching the wafer including an etching solution or plasma is well known to one skilled in the art as described in page 13 of the specification. Therefore, at the time of the invention, using any method will be obvious in order to etch the wafer with a reasonable expectation of success.

Referring to the limitation of aspect ratio of the etch portion greater than 1 or at least about 10, this would depend on the structure being fabricated and the time of etching. An example of a structure having aspect ratio of greater than 1 is the zone plates for the x-ray application as shown in page 3 of the specification or the aspect ratio is desired at as high as several hundred (specification: page 2, line 20). Therefore, at the time of the invention, the aspect ratio would have to be determined through routine experimentation depending the structure being manufacture and the time of etching in order to form a structure with a reasonable expectation of success.

Referring to claim 89, admitted prior art also discussed using e-beam lithography. This would provide claimed e-beam resist material. Therefor, it would also have to be structurally stable during etching.

8. Claims 5, 6, 26, 27, 32, 33, 53, 54, 58, 59, 79, 80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu or Liu/admitted prior art as applied to claims 1, 25, 28, 52, 57, 78 above, and further in view of Chen (US 5, 723,387).

Liu doesn't describe the electroplating method for forming the Cu. Chen teaches an electroplating method for forming Cu interconnects (claims 6, 7). It would have been obvious

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for one skilled in the art to deposit Cu in light of Chen because Chen teaches that electroplating method can form very small scale Cu interconnects on semiconductor substrate.

9. Claims 12, 39, 65, 93 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu or Zandveld as applied to claims 10, 37, 63, 88 above.

Unlike claimed invention, Liu and Zandveld do not describe the direction of the particle beam hitting the substrate is of less than 90 degrees with respect to the plane of the wafer surface or the particle tracks intercept within the wafer. However, the amount of particle beam hitting the wafer surface would depend on the angle it hits on the wafer; therefore, it would have been obvious for one skilled in the art to determine the angle the particle beam hitting the wafer which would provide the particle tracks to be intercepted in the wafer surface through routine experimentation in order to obtain the optimum angle for the wafer surface treatment with a reasonable expectation of success.

10. Claims 85, 91 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu or Zandveld and admitted prior art as applied to claims 1, 88 above, and further in view of Surendra et al. (US 6,365,326).

Applied prior art doesn't describe forming an etch stop to the surface that is opposite the surface having resist material. Surendra shows a method where an etch stop to the surface that is opposite the surface having resist material (col. 5, line 15-25). It would have been obvious to one skill in the art in light of Surendra to use the etch stop layer to stop the etching of the substrate with a reasonable expectation of success.

Allowable Subject Matter

11. Claims 29, 63, 81, 86, 87, 97, 98 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 29, 63, 81, 87, 98 are allowable because applied prior art doesn't suggest to use the energy of approximately 0.5 MeV or 500 thousand Volts or one hundred million electron volts to create particle tracks. Applied prior art such as Zandveld uses energy of about 30keV.

Claims 86 is allowable because applied prior art doesn't suggest forming the structure of nanomachined comprises a zone plate structure for x-ray application beyond 1000 volts where the etching pattern is a zone plate pattern having a width of at least 5 nm, the aspect ratio of the depth of the etched particle tracks to the width of the smallest zone plate pattern is at least 10, and the zone structure has a diameter of at least about 1 mm. Applied prior art such as Zandveld and Liu describes structures such as dual damascene and diode.

Claim 97 is allowable because applied prior art doesn't provide the motivation or suggest that the aspect ratio formed can be in the order of 1000.

Claims 99-104 are allowed with the same reason of allowable claim 29.

Response to Arguments

12. Applicant's arguments filed 1/21/04 have been fully considered but they are not persuasive.

Referring to applicant's arguments that irradiation with ions beams with energy in the range of 1-320 keV as disclosed by the cited references is not capable of forming particle tracks and Zandveld and Liu do not inherently teach formation of particle tracks capable of discreate

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etching. This is found unpersuasive because there are no factual evidences to show that the cited references do not form any particle tracks at all. Also, the claims, at least the independent claims, do not limit to any level of energy being used. The particle tracks, as far as those claimed concerned, are formed by the method of irradiation. Since the cited references use the same method, irradiation of the substrate, even at a lower energy, it would inherently provide some level of particle tracks. This reads on claimed of forming particle tracks. It is the burden to applicant to show that the cited references form no particle tracks at all.

Referring to applicant's argument that Zandveld and Liu do not expressly teach formation of the particle tracks capable of discreet etching or etching guided by the particle tracks is acknowledged. For the formation of particle tracks of the cited references, please see the argument above. Referring to the limitations of the particle tracks capable of discrete etching guided by particle tracks or the etching is guided by the particle tracks, these claims describe the properties of the particle tracks. Since the methods of Zandveld and Liu form particle tracks, it would be inherently to have those properties.

Referring to applicant's argument that the examiner doesn't provide scientific reasoning for the theory that irradiation of a wafer surface with a charged particle beam necessary forms particle tracks. As already discussed above, the particle tracks, as far as those claimed concerned, are formed by the method of irradiation method and not limit to any particular level of energy. A "suitable energy" in the claims can be anything. Even though cited references use a different energy levels. It would inherently from some level of particle tracks since it is done by the same methods as that of the claims.

Election/Restrictions

13. Newly submitted claims 105-123 directed to an invention that is independent or distinct from the invention originally claimed for the following reasons: they are product claims and the method claims can be used to form another materially different product such as forming dual damascene or diode structure.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 105-123 withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Claim Rejections - 35 USC § 112

14. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

15. Claims 23, 28, and 76 recite the limitation "said etched portion". There is insufficient antecedent basis for this limitation in the claim.

16. Claim 89 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

It is unclear by "said pattern forming resist material is an e-beam resist material configured to be structurally stable during etching."

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Claim Objections

17. Claims 82 and 83 are objected to because of the following informalities: they are the same as claims 13 and 14 and they all depend on the same claim. Appropriate correction is required.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to DuyVu n Deo whose telephone number is 703-305-0515.

DVD

April 7, 2004

A handwritten signature in black ink, appearing to be 'DVD' or similar, written below the date.